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REPORT OF WATER QUALITY IN RICE LAKE

1972



Ontario

Ministry
of the
Environment

The Honourable
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Minister

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REPORT OF WATER QUALITY

in

RICE LAKE 1972

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PREFACE

The Province of Ontario contains many thousands of beautiful small inland lakes which are most attractive for recreational use. Lakes close to urban areas and accessible by road often receive heavy use in terms of cottage development, camp sites, trailer parks and picnic areas.

A heavy influx of people may subject a lake and its surrounding environment to great stress. In many cases, developments are carried out on attractive lakes only to find that when this is complete the lake qualities which were initially so appealing have been damaged. The appearance of the shoreline can be marred by construction, fishing ruined by over harvesting or the growth and decay of excessive amounts of algae and weeds. Motor boats introduce noise and petroleum pollution. Inadequate disposal of human wastes can place a great stress on the lake environment.

The accepted custom of having "a place at the lake" continues to apply pressure for more development, giving rise to an even greater expansion of problems.

The Ontario Ministry of the Environment is attempting to bring some of these stress factors under control with a variety of programs. The cottage pollution control program was initiated in 1967 and was expanded in 1970 in order to solve the cottage waste disposal problem in recreational lakes. There are three on-going studies carried by the Ministry.

- (1) evaluation of existing waste disposal systems and enforcement of repairs to those found to be unsatisfactory.

(2) research to improve the knowledge of septic tank operation and effects in shallow soil areas and evaluation of alternative methods of private waste disposal.

(3) evaluation of present water quality in a number of recreational lakes. A totally undeveloped lake near Huntsville was studied in 1972, in order to obtain more information about natural water quality conditions within a Precambrian Lake, which would assist in defining any unnatural conditions encountered in the developed lakes surveyed.

This report on Rice Lake is one of a series dealing with the water quality aspects of the recreational lakes studied in 1972. As well as defining the present status of water quality in the lakes, the data are meant to provide an historical reference for comparison of conditions at any future time.

SUMMARY

Surveys were carried out in Rice Lake in 1972 in June, August and September to evaluate the present water quality with respect to bacteria, suspended algae and mineral chemistry. Plant nutrient and dissolved oxygen concentrations in the surface and bottom waters were determined.

Rice Lake is located in the counties of Peterborough and Northumberland. The lake lies in the Trenton Bedrock formation which is a flat limestone bedrock buried beneath a deep mantle of soil. The surrounding area is characterized by deep, well drained loam based soils, with a rolling terrain.

The overall bacterial status of Rice Lake was quite acceptable and only one pollution source was noted. This source at Gores Landing (Station 30) had substantially high total and fecal coliform bacterial levels during the spring and summer surveys. It is recommended that this area be investigated further so that the source of the contamination be identified and corrected.

Rice Lake is highly enriched and supports large amounts of suspended algae. Although shallow and generally well-mixed and adequately supplied with dissolved oxygen from surface to bottom, the lake exhibits considerable patchiness in distribution of both nutrients and suspended algae. The Otonabee River was an important source of nutrients.

PURPOSE OF THE SURVEYS

The surveys were designed, and tests selected, in order to evaluate the present conditions in the lakes with respect to:

- concentration of bacteria
- plant nutrients and algae
- water quality with depth
- inventory of shoreline development

As a result of human activity in the recreational lake environment, some wastes may reach the lake itself and this can lead to either or both of two major types of water quality impairment, microbial contamination and excessive growths of algae and aquatic plants. The two problems can result from a common or different source of pollution, but the consequences of each are quite different.

Microbial contamination by raw or inadequately treated sewage does not significantly change the appearance of the water but poses an immediate public health hazard if the water is used for drinking or swimming. This type of pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions since most disease causing bacteria do not persist in the lake.

Nutrient enrichment, or eutrophication, results from the addition of plant fertilizers which occur naturally and are also present in virtually all forms of raw or treated human wastes. High concentrations of these fertilizers (plant nutrients), mainly nitrogen and phosphorus, support extensive growths of rooted aquatic plants and of microscopic free-floating plants called algae. Eutrophication greatly affects the lake appearance but generally does not pose a health hazard. Problems due to nutrient enrichment are generally long lasting and may become irreversible.

Changes in water temperature, dissolved oxygen and quality with depth are very important characteristics of a lake and were examined in the surveys.

Aquatic weed beds provide shelter and food for many kinds of fish. Too much growth is undesirable since it can upset the oxygen balance in the lake and can interfere with recreational uses of the lake.

DESIGN OF THE SURVEYS

Timing

Five day bacteriological, chemical and biological surveys were carried out from June 8 to 12, from August 9 to 13 and from September 24 to 28.

A proper estimation of the bacterial population requires several measurements over a period of time which can then be averaged as a geometric mean. Measurements over 5 consecutive days at each station are regarded as the minimum number which will give reliable bacterial data.

Chemical samples were collected on the first and last days of the surveys at inlet and outlet stations and on the first, third and fifth days at the mid-lake stations. Chlorophyll samples were collected each day at the inlet and mid-lake stations.

Selection of Sample Locations

Forty-three bacteriological sample sites were established over the whole lake. Chemical samples were collected at 3 inlet stations, one outlet station and a 4 mid-lake stations. In addition to these surface samples,

chemical and bacteriological samples were taken from the bottom water at the mid-lake stations.

Field Tests

The temperature and dissolved oxygen values were measured at the deep water stations with an electronic probe lowered into the lake and water clarity was measured with a Secchi disc, (Figure 1). The pH and conductivity of the samples were measured in the field.

Bacteriological Tests

Three groups of bacteria were determined on each sample: total coliforms, fecal coliforms, fecal streptococci. These organisms are used as "indicators" of fecal contamination. Many diseases common to man can be transmitted by feces, consequently, the probability of occurrence of these diseases is usually highest in areas where the water is contaminated. The total coliforms, fecal coliforms and fecal streptococci organisms are all indigenous to man and other warm-blooded animals and are found in the colon and feces in tremendous numbers. Hence, these indicator organisms in the water denotes the presence of fecal contamination and hence the risk of disease causing organisms.

Standard plate count (SPC) determinations were made on some mid-lake stations in order to determine densities of some natural water bacteria. The SPC media will only support the growth of those organisms that do not require special nutrients, oxygen requirements and/or incubation temperatures. The SPC is a measure of bacterial activity.

Chemical Tests

Hardness, alkalinity, chloride, iron and conductivity were measured

The "Secchi Disc Reading" is obtained by averaging the depth at which a 23cm (9") dia. black and white plate, lowered into the lake just disappears from view and the depth where it reappears as it is pulled up.

Most of the free-floating algae are suspended in the illuminated region between the lake surface and 2 times the Secchi disc reading.

Clear, algae-free lake:
Secchi disc readings tend to be greater than 3m (9 feet).

Turbid or algae-rich lake:
Secchi disc readings tend to be less than 3m (9 feet).

Secchi Disc Reading

2 times Secchi disc reading

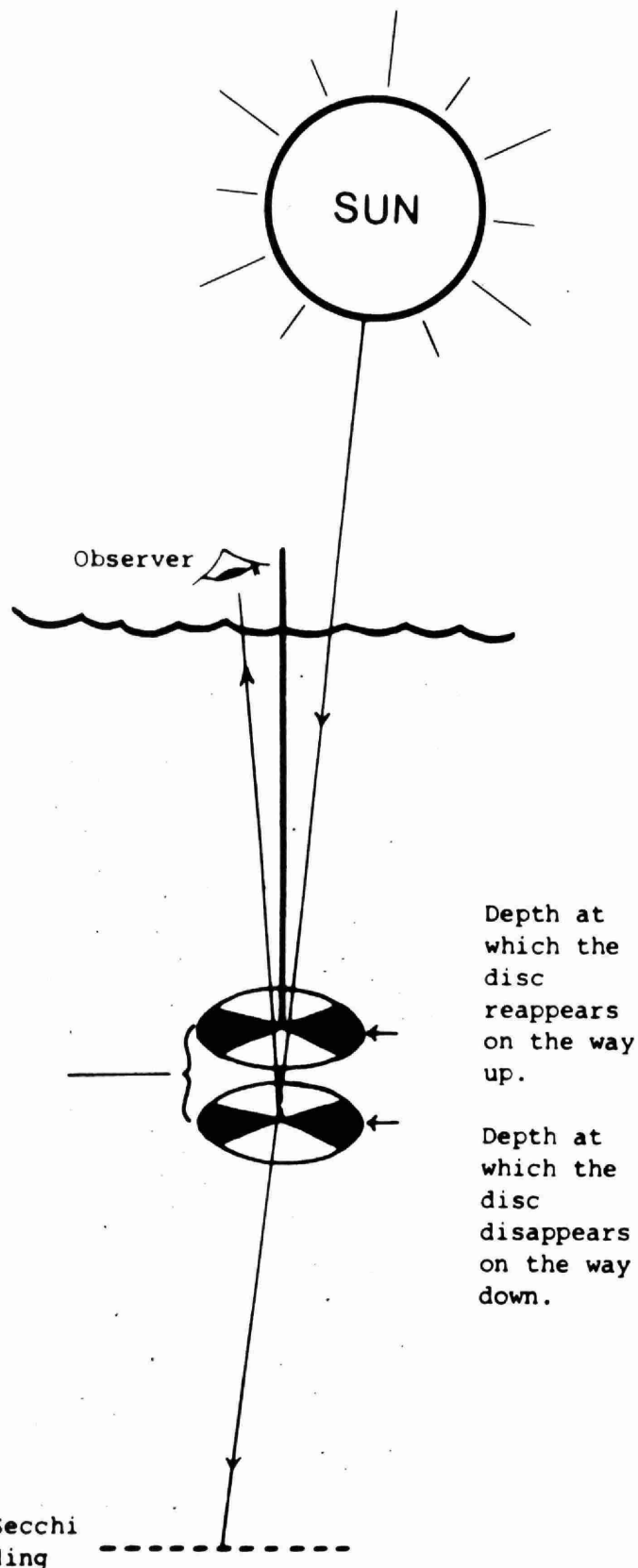


FIGURE 1: USE OF THE SECCHI DISC TO DETERMINE WATER CLARITY.

in order to define the mineral composition of the water. The types of plants and animals which thrive, effects of toxic materials and suitability of the lake for various management techniques depend on the mineral content.

Total and soluble phosphorus were measured in the inlet and bottom water samples while total phosphorus only was measured in the mid-lake and outlet surface samples. Soluble phosphorus concentrations are used mainly to substantiate various interpretations of the total phosphorus concentrations.

The total kjeldahl nitrogen is essentially the amount of nitrogen contained in organic material. It was measured in all of the chemical samples. The soluble forms of nitrogen, ammonia, nitrite and nitrate were measured in the inlet and bottom water samples. They are particularly important in bottom waters since nitrogen is regenerated from decaying organic matter in these forms.

Chlorophyll a concentrations are an indication of the amount of algae in the water. The live algae are confined mainly to the illuminated surface waters which extend down to a depth of about twice the Secchi disc reading. The chlorophyll samples were collected by raising the sample bottle through the depth of the illuminated surface waters as it filled. The sample was then representative of the algal density through the sampling depth.

DESCRIPTION OF THE RICE LAKE AREA

Lake and Soil Characteristics

Rice Lake is situated in Otonabee Township, Peterborough County, and Alnwick, Hamilton and South Monaghan townships, Northumberland County.

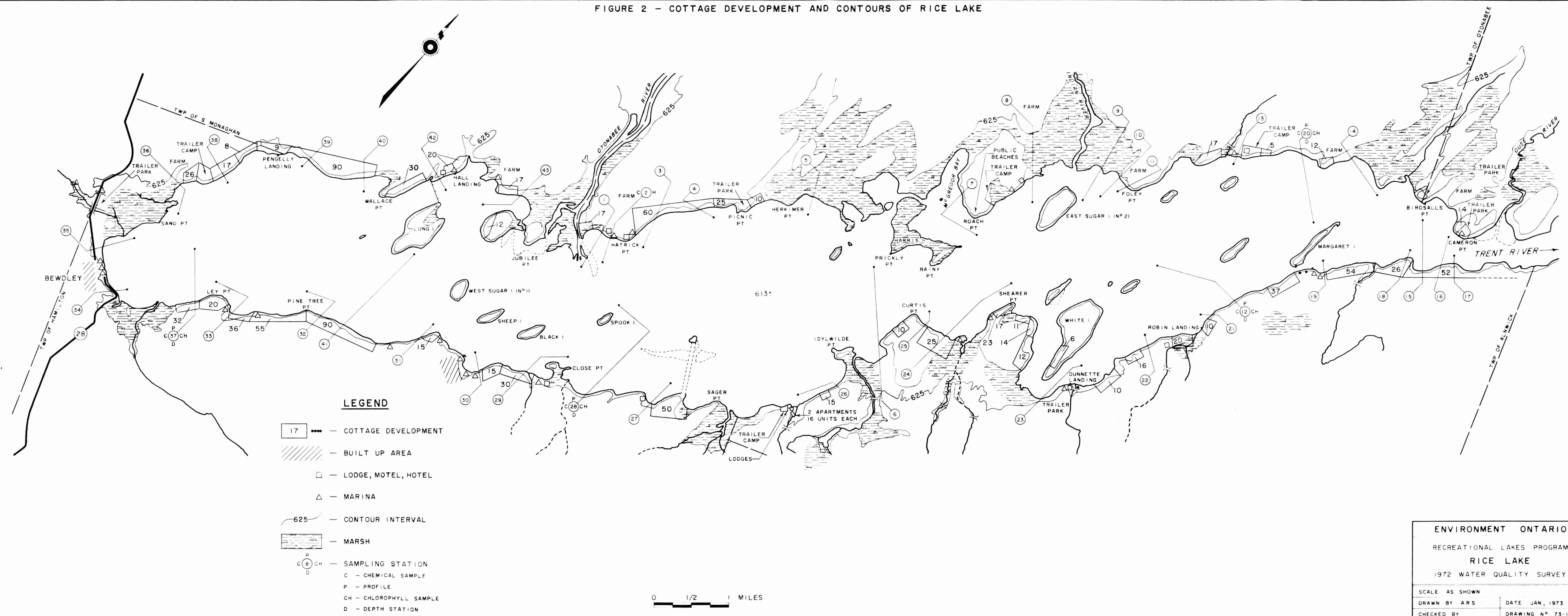
It is a long and slender lake with an approximate length of 29 kilometers (18 miles) and an average width of 3 kilometers (2 miles). The lake has a total shoreline length of 117 kilometers (73 miles) with a surface area of 64 square kilometers (25 square miles). Its maximum depth is 10 meters (31 feet) and it has a mean depth of 4 meters (12 feet).

The lake is surrounded by a rolling terrain which is mainly covered with a loam overburden. The north shore of the lake is composed mostly of the Otonabee soil series. This soil is developed from a very calcareous loam till containing many limestone fragments. This area has a rolling topography and has a good drainage. Low lying areas along the Otonabee River are composed of the Muck soil series. This series is usually comprised of partially decomposed organic material overlying a bed of mineral soils. The soils around the west end and the mid-section of the lake belong to the Fox series. This soil is composed of coarse textured sandy loam with an undulating well drained topography and is relatively stone free. The remainder of the south shore is primarily composed of the Guelph soil series, which consists of medium textured soils formed on loam till, having a rolling topography, good drainage and with a few stones in the surface soil.

Generally, the soil series around the lake have an average depth of 1.5 meters (5 feet) of overburden. Most of the area is well forested with both deciduous and coniferous trees.

The Rice Lake watershed is part of the Trent River drainage basin. The immediate watershed of the lake covers an area of 930 square kilometers (358 square miles) of land. It is the last lake in the Trent Severn System before the Bay of Quinte. The three inlets to the lake are located along its north shore.

FIGURE 2 - COTTAGE DEVELOPMENT AND CONTOURS OF RICE LAKE



The main inlet is the Otonabee River which is part of the Trent Severn Canal System. The Otonabee River exits the south end of Clear Lake and flows through the Village of Lakefield and the City of Peterborough and then enters the northeast area of Rice Lake. Another inlet is the Indian River which exits the south end of Dummer Lake and enters Rice Lake across from East Sugar Island. The third inlet is the Ouse River which enters Rice Lake at its east end and drains the farmland and swamp areas north of Highway No. 7. The only outlet from the lake is the Trent River which passes through the Village of Hastings and then enters the Bay of Quinte at Trenton.

Shoreline Cottage Development and Water Usage

The shoreline of Rice Lake is heavily developed with the exception of some swampy areas. There are approximately 1950 cottages, 12 lodges, 22 marinas and 8 trailer parks on the shoreline of the lake. There are several urban communities such as Bewdley, Gores Landing and Harwood located on the perimeter of the lake (Figure 2).

Most of the cottagers and the urban communities use wells as their source of domestic water supply. The Village of Hastings located downstream of Rice Lake is served by a municipal water works system which obtains its supply from the Trent River. The lake is actively used for recreational swimming as well as for winter sports. The lake offers a productive sport fishery of maskinonge (muskie), walleye, largemouth and smallmouth bass, rock bass and perch. Many streams in the area provide trout fishing. The Rice Lake Tourist Association, with the co-operation of the Ministry of Natural Resources, owns and operates a muskie rearing pond. Some 5,000 fingerlings are planted in the lake and rivers each year.

There were no direct discharges of raw or treated wastes into Rice Lake from municipal or communal sewage treatment facilities, although treated sewage wastes from the Peterborough treatment is discharged into the Otonabee River. The area residents are provided with four municipal solid waste disposal sites. The sites are located on Lot 19, Concession V and Lot 7, Concession III, Alnwick Township, Lot 28, Concession VIII and Lot 2, Concession VIII, Hamilton Township and Lot 16, Concession III, South Monaghan Township. All sites appear to be satisfactory and are not posing any pollution hazards to the lake.

RESULTS AND DISCUSSION

Bacteriology

The quantities of bacteriological data necessitated statistical methods to summarize the results into a concise presentation without the inconsistency associated with manual interpretation. The methods used are based on the analysis of variance and Barlett's test of homogeneity by which stations on a lake can be grouped into areas with the same bacterial level. Areas or stations with only slight differences in bacterial concentration can be isolated. It was found on previous work that areas, or stations, with significantly higher bacterial numbers generally indicated a pollution input. Details of statistical methods and data are available on request.

The water quality of Rice Lake during the spring, summer and fall surveys was found to be satisfactory and within the Ministry of the Environment criteria for total body contact recreational use (MOE 1972) which states: Where ingestion is probable, recreational waters can be considered impaired when the coliform (TC), fecal coliform (FC), and/or enterococcus (FS)

FIGURE 3 - DISTRIBUTION OF BACTERIA IN JUNE

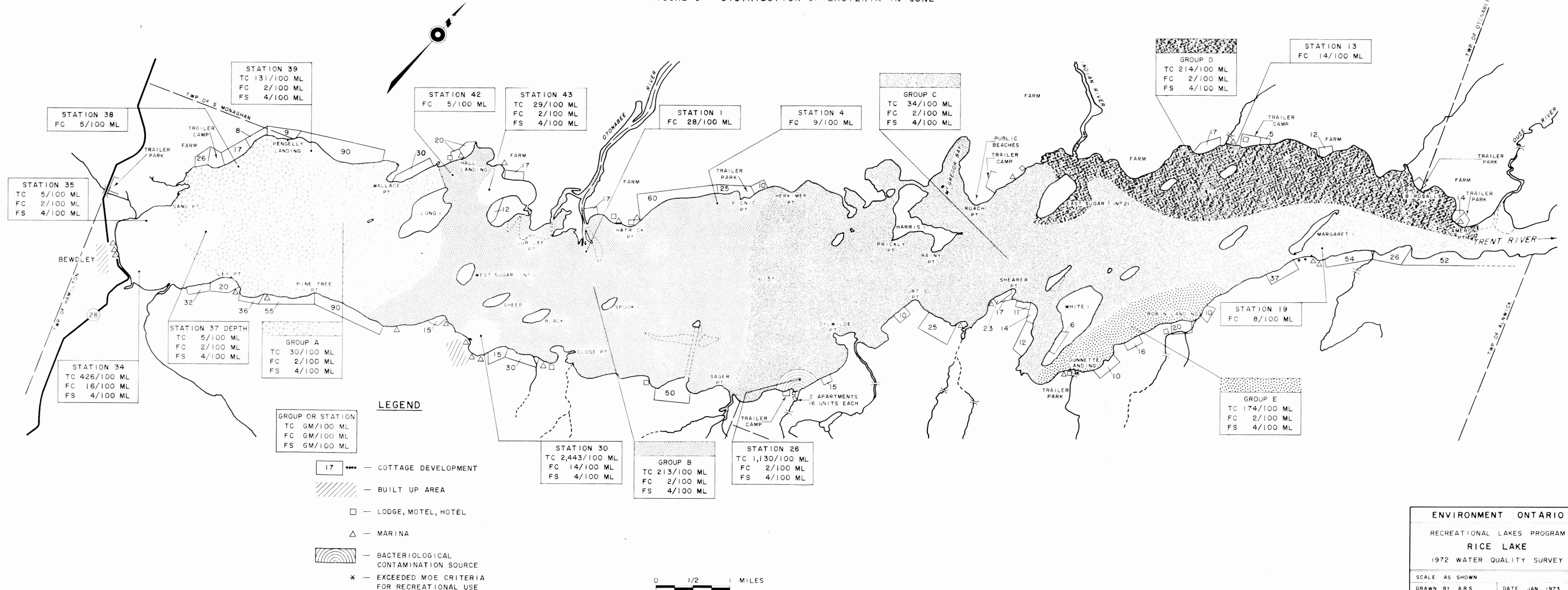
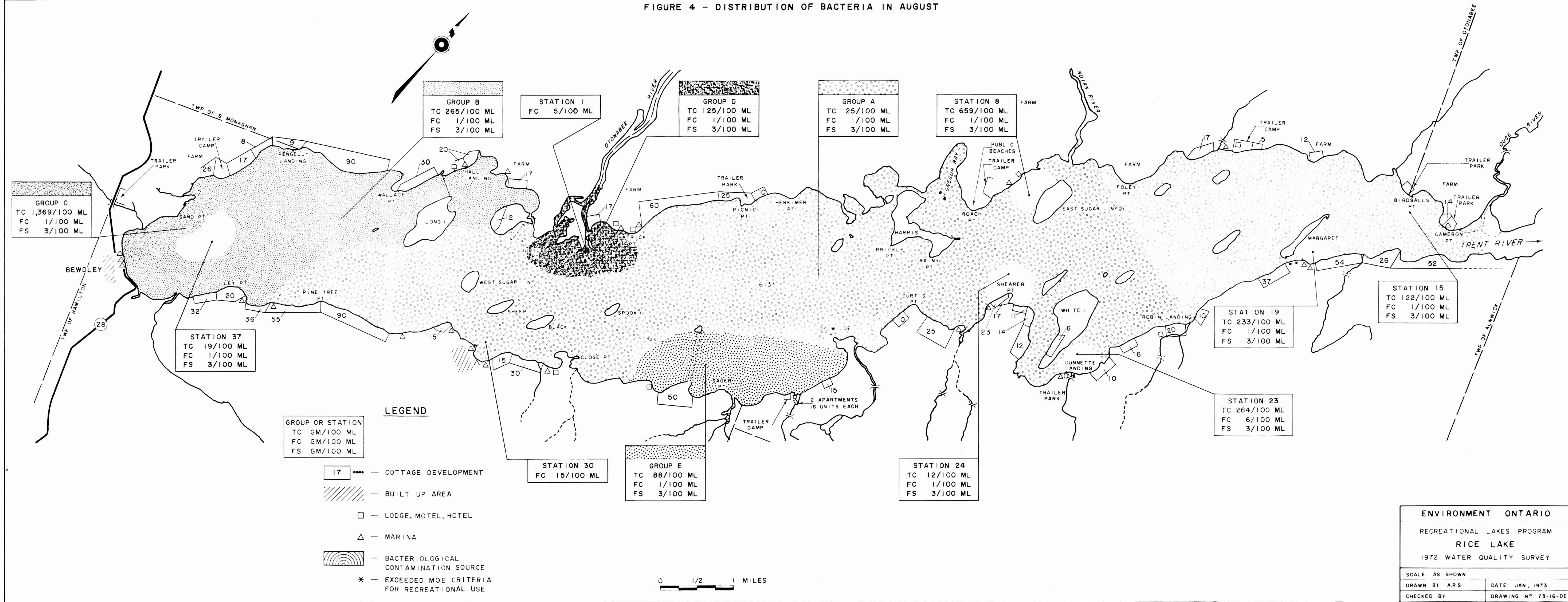


FIGURE 4 - DISTRIBUTION OF BACTERIA IN AUGUST



geometric mean density exceeds 1000, 100 and/or 20 per 100 ml respectively.⁽¹⁾

During the spring bacteriological survey the lake was divided statistically into five major groups and seven stations (Figure 3). The western basin (Group A), displayed a total coliform mean of 30 TC/100 ml and a fecal coliform mean of 2 FC/100 ml. The mid-lake group (Group B) had a total coliform mean of 213/100 ml and a fecal coliform mean of 2/100 ml. The largest group (Group C) comprising nearly the entire eastern half of Rice Lake had a low total coliform mean of 34 TC/100 ml and 2 FC/100 ml. Group D, situated in the northeastern portion of the lake within the influence of three rivers, had 214 TC/100 ml and 2 FC/100 ml while Group E in the southeastern portion had 174 TC/100 ml and 2 FC/100 ml.

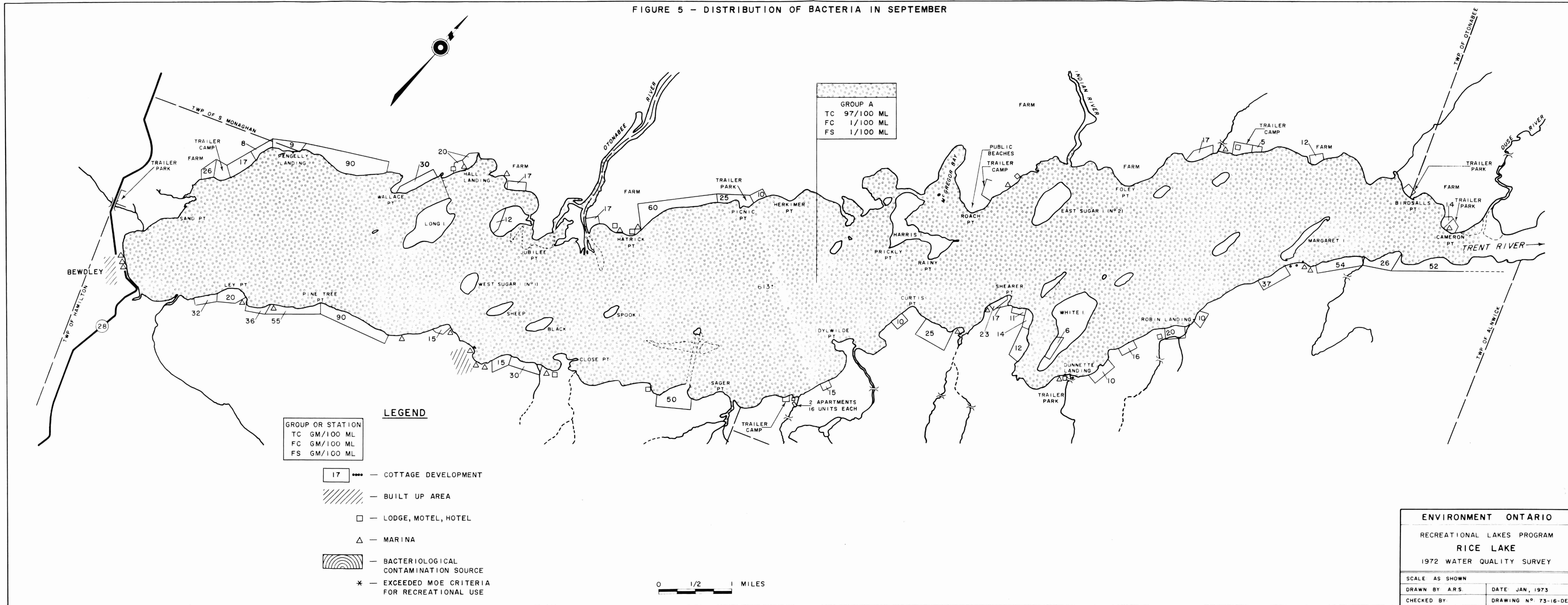
Stations 26, 34, 35, 37 depth, 39 and 43 were statistically isolated with respect to TC and/or FC levels (Figure 3).

Rice Lake was homogeneous for fecal streptococcus having a geometric mean of 4 FS/100 ml. During the spring survey Station 30, having 2443 TC/100 ml and 14 FC/100 ml was definitely affected by bacterial contamination.

From the period August 9 to 13 the counts were generally lower than those encountered in the spring survey (Figure 4). Group A, comprising the major area of the lake had a geometric mean of 25 TC/100 ml and 1 FC/100 ml. The western basin (Group B), around the town of Bewdley had a low total coliform mean of 25 TC/100 ml with a fecal coliform mean of 1 FC/100 ml. The extreme western portion of the lake (Group C) displayed the highest total coliform mean of any group with 1369 TC/100 ml and a fecal coliform mean of 1 /100 ml. Geometric means of 125 TC/100 ml and 1 FC/100 ml were encountered at the outflow of the Otonabee River (Group D), while the southern mid-lake

(1) Water Quality Criteria, Ontario Ministry of the Environment, 1972.

FIGURE 5 - DISTRIBUTION OF BACTERIA IN SEPTEMBER



area (Group E) had means of 88 TC/100 ml and 1FC/100 ml. Six stations (8, 15, 19, 23, 24 and 37) were statistically isolated with respect to TC and/or FC levels (Figure 4). Fecal streptococcus bacterial levels were homogeneous for the summer survey with a geometric mean of 3 FS/100 ml.

Rice Lake bacteriological water quality had improved by the fall survey (Figure 5). All three bacterial parameters were homogeneous with total coliforms having a geometric mean of 97 TC/100 ml, fecal coliforms having 1 FC/100 ml and fecal streptococcus having 1 FS/100 ml.

The effect of rainfall in washing in bacteria from the shoreline was indicated during the summer survey (see P. A-2 for explanation). The Campbellford Meteorological Station was recorded 0.95 and 0.46 inches of rainfall during the two days prior to the survey. Consequently, total coliform counts were significantly higher on the first day of the survey (August 9).

Chemistry

There was no temperature stratification observed during the three surveys on Rice Lake and both temperature and dissolved oxygen were relatively uniform throughout the water column. Such conditions are not uncommon in shallow, well mixed lakes such as Rice Lake. During the June, August and September surveys, the dissolved oxygen concentrations never fell below 70 percent saturation and frequently were above 100 percent saturation. Temperatures, during the three surveys ranged from 16 to 19°C, 18 to 21°C and 14 to 18°C, respectively.

Rice Lake is a moderately hard water lake with hardness ranging from 100 to 107 mg/l as CaCO_3 . The alkalinity and conductivity values correlate well with hardness and along with chloride and pH data indicate no unusual mineral water quality characteristics.

	<u>Overall Ranges</u>
Alkalinity	72 - 93 mg/l as CaCO_3
Conductivity	182 - 315 $\mu\text{mhos/cm}$
Chloride	6 - 7 mg/l
pH	6.8 - 9.2 units

It should be noted that the summer pH values in Rice Lake exceeded the Ministry of the Environment's criteria for public surface water supplies as pH values above 8.5 units can cause eye irritation to swimmers. The mean pH values during the spring, summer and fall surveys were 8.0, 8.9 and 7.5 respectively, and the uptake of inorganic carbon by aquatic plants and algae no doubt brought about the observed high mid-summer values.

Rice Lake appears to be highly enriched with nutrients which have promoted excessive weed and algal growth. The kjeldahl nitrogen and total phosphorus concentrations at Station 2 near the mouth of the Otonabee River were very high averaging 540 and 70 $\mu\text{g/l}$ respectively, and differed very little from those in the open lake. Although high concentrations prevailed at all four mid-lake sampling locations, total phosphorus was not uniform throughout the lake with much higher springtime concentrations at Station 28 which is probably within the influence of the Otonabee River. During the mid-summer survey, however, considerably more phosphorus was found at Station 37 than at Station 28 and was associated with much larger amounts of chlorophyll *a* than was found at Station 28 (see below). Iron concentrations were generally low throughout the lake averaging 0.14 mg/l. Slightly higher iron concentrations (averaging 0.22 mg/l) were observed at Station 2 (Otonabee River inflow) during the spring survey.

Chlorophyll a and Water Clarity

As indicated by chlorophyll a concentrations, all four mid-lake sampling locations were characterized by moderately large amounts of suspended algae in the illuminated zone of the lake during the spring and summer surveys and small amounts during the autumn survey. Considerable lake-wide variation in chlorophyll a concentration was present and indicates the patchiness of areas with optimum environmental conditions for growth of suspended algae. For example, during the five day summer survey, the mean chlorophyll a concentration at Station 28 was 14 ug/l but over the same period of time the mean at Station 37 was 33 ug/l. The mean chlorophyll a concentration in the lake over the three surveys of 11.3 ug/l was accompanied by a mean Secchi disc transparency of only 0.5 meters, indicating lake water of poor clarity. Nutrients such as phosphorus were in abundant supply and no doubt contributed to the proliferation of algae in the lake.

On a scale of lake enrichment as indicated by chlorophyll a concentrations and water transparency, the status of Rice Lake is indicated by its proximity to Lake Scugog and the Western Basin of Lake Erie, two extremely enriched bodies of water (Figure 6). Preliminary studies on other lakes similarly affected by nutrient loadings from municipal waste treatment facilities have indicated an improvement in water quality (increased water clarity and smaller amounts of suspended algae) following either diversion of the waste effluent or phosphorus removal during the treatment process. Following the initiation of the phosphorus removal at the Peterborough sewage treatment plant by the end of 1973, a gradual improvement in Rice Lake water quality will be looked for.

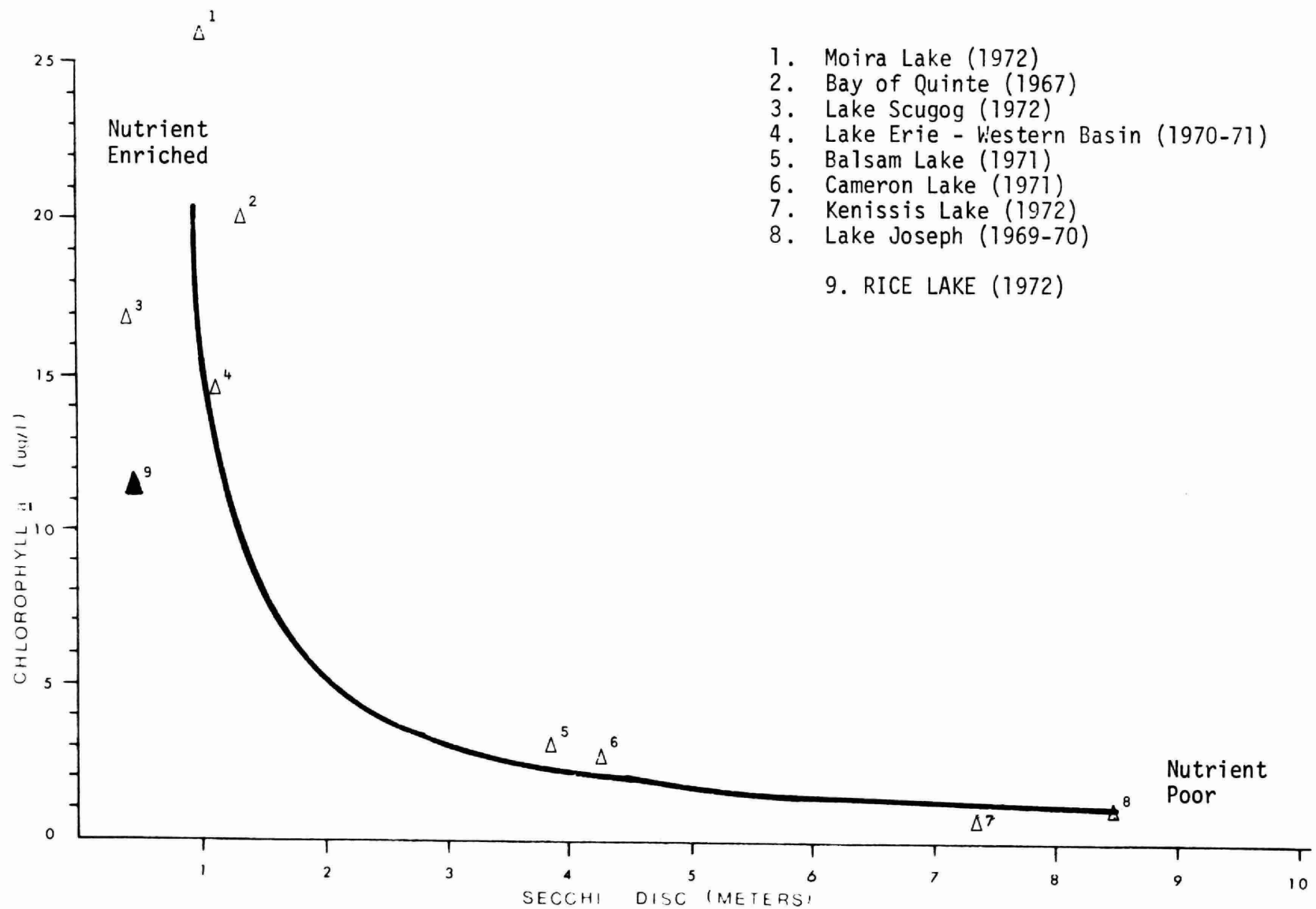


Figure 6: The mean of chlorophyll a and Secchi disc measurements in Rice Lake relative to a curve describing the chlorophyll a - Secchi disc relationship in many Ontario lakes. Eight other well known lakes are included for comparison with Rice Lake.

Aquatic Plants

In addition to the interpretation of aerial photographs taken of the Rice Lake weed beds in 1972, an aquatic plant survey was carried out by staff of the Ministry of the Environment during 1969. Some of the more significant findings of both surveys have been incorporated into this report.

Rice Lake supports heavy growths of aquatic plants, with the mouth of the Indian and Otonabee rivers and the White Island and Bewdley areas supporting very dense stands of submerged vegetation (Figure 7)*. During May, the predominant species was curly-leaf pondweed which matured in late May with seedheads visible at the water surface. This was replaced by coontail, Canada water weed and milfoil during June and July, with milfoil the dominant species. Tapegrass was the last plant to make its appearance in the annual succession, commencing growth in late June.

Normally, with increased plant productivity, there is a corresponding increase in fish production. Rice Lake, due to its high productivity, has sustained heavy fishing pressure with good yields, whereas in a less enriched lake, there probably would have been a decline in fish stocks, if subjected to the same pressure.

From an aesthetic standpoint, the proliferation of aquatic plants has been undesirable and it has adversely affected swimming, power boating and water skiing. Control of aquatic plant growth is necessary if Rice Lake is to continue to support a variety of recreational activities (refer to page A-9). During the summer of 1973, a study was conducted on Chemung Lake to determine the ecological ramifications of large scale mechanical weed harvesting. If the results of this study are favourable, mechanical harvesting might offer a solution to the aquatic weed problem in Rice Lake.

* Submerged plant growths in deeper areas of the lake which were not depicted in the aerial photographs may have been omitted from Figure 7.

FIGURE 7 - DISTRIBUTION AND DENSITY OF AQUATIC PLANT GROWTH IN RICE LAKE



LEGEND

-  — LIGHT TO MODERATE AQUATIC PLANT GROWTH
-  — HEAVY AQUATIC PLANT GROWTH
-  — MARSH

0 1/2 1 MILES

ENVIRONMENT ONTARIO	
RECREATIONAL LAKES PROGRAM	
RICE LAKE	
1972 WATER QUALITY SURVEY	
SCALE: AS SHOWN	
DRAWN BY: A.R.S.	DATE: JAN, 1973
CHECKED BY:	DRAWING NO: 73-16-DE

Future Considerations

In view of the substantially high total and fecal coliform bacterial levels near Gores Landing (Station 30) during the spring and summer surveys, it is recommended that this area be investigated further so that the source of the contamination be identified and corrected.

Rice Lake's status of enrichment should be followed closely over the next several years to determine changes in water clarity and abundance of suspended algae which materialize following improved treatment of municipal sewage wastes at communities on the Upper Kawartha Lakes Watershed and especially as related to the proposed removal of phosphorus from sewage at the Peterborough waste treatment plant. In this regard, it is recommended that representatives of cottagers on the lake take part in the "Chlorophyll - Secchi disc 'Self-Help' Program". Details of the program may be obtained by contacting the Ministry of the Environment, Biology Section, P.O. Box 213, Rexdale, Ontario, M9W 5L1, telephone 248-3058.

INFORMATION OF GENERAL INTEREST TO COTTAGERS MICROBIOLOGY OF WATER

For the sake of simplicity, the microorganisms in water can be divided into two groups: the bacteria that thrive in the lake environment and make up the natural bacterial flora; and the disease causing microorganisms, called pathogens, that have acquired the capacity to infect human tissues.

The "pathogens" are generally introduced to the aquatic environment by raw or inadequately treated sewage, although a few are found naturally in the soil. The presence of these bacteria does not change the appearance of the water but pose an immediate public health hazard if the water is used for drinking or swimming. The health hazard does not necessarily mean that the water user will contract serious waterborn infections such as typhoid fever, polio or hepatitis, but he may catch less infections of gastroenteritis (sometimes called stomach flu), dysentery or diarrhea. Included in these minor afflictions are eye, ear and throat infections that swimmers encounter every year and the more insidious but seldom diagnosed, subclinical infections usually associated with several water born viruses. These viral infections leave a person not feeling well enough to enjoy holidaying although not bedridden. This type of microbial pollution can be remedied by preventing wastes from reaching the lake and water quality will return to satisfactory conditions within a relatively short time (approximately 1 year) since disease causing bacteria usually do not thrive in an aquatic environment.

The rest of the bacteria live and thrive within the lake environment. These organisms are the instruments of biodegradation. Any organic

matter in the lake will be used as food by these organisms and will give rise, in turn to subsequent increases in their numbers. Natural organic matter as well as that from sewage, kitchen wastes, oil and gasoline are readily attached by these lake bacteria. Unfortunately, biodegradation of the organic wastes by organisms uses correspondingly large amounts of the dissolved oxygen. If the organic matter content of the lake gets high enough, these bacteria will deplete the dissolved oxygen supply in the bottom waters and threaten the survival of many deep water fish species.

The standard plate count (SPC) populations given in the text supply an indication of the number of these bacteria in the lake.

RAINFALL AND BACTERIA

The "Rainfall Effect" referred to in the text, relates to a phenomena that has been documented in previous surveys of the Recreational Lakes. Heavy precipitation has been shown to flush the land area around the lake and the subsequent runoff will carry available contaminants including sewage organisms as well as natural soil bacteria with it into the water.

Total coliforms, fecal coliforms and fecal streptococci, as well as other bacteria and viruses which inhabit human waste disposal systems, can be washed into the lake. In Precambrian areas where there is inadequate soil cover and in fractured limestone areas where fissures in the rocks provide access to the lake, this phenomenon is particularly evident.

Melting snow provides the same transportation function for bacteria, especially in an agricultural area where manure spreading is carried out in the winter on top of the snow.

Previous data from sampling points situated 50 to 100 feet from shore indicate that contamination from shore generally shows up within 12 to 48 hours after a heavy rainfall.

WATER TREATMENT

Lake and river water is open to contamination by man, animals and birds (all of which can be carriers of disease); consequently, NO SURFACE WATER MAY BE CONSIDERED SAFE FOR HUMAN CONSUMPTION without prior treatment, including disinfection. Disinfection is especially critical if coliforms have been shown to be present.

Disinfection can be achieved by:

(a) Boiling

Boil the water for a minimum of five minutes to destroy the disease causing organisms.

(b) Chlorination Using a Household Bleach Containing 4 to 5.1/4% Available Chlorine

Eight drops of a household bleach solution should be mixed with one gallon of water and allowed to stand for 15 minutes before drinking.

(c) Continuous Chlorination

For continuous water disinfection, a small domestic hypochlorinator (sometime coupled with activated charcoal filters) can be obtained from a local plumber or water equipment supplier.

(d) Well Water Treatment

Well water can be disinfected using a household bleach (assuming

strength at 5% available chlorine) if the depth of water and diameter of the well are known.

CHLORINE BLEACH
per 10 ft depth of water

Diameter of Well Casing In Inches	One to Ten Coliforms	More than Ten Coliforms
4	.5 oz	1 oz.
6	1 oz.	2 oz.
8	2 oz.	4 oz.
12	4 oz.	8 oz.
16	7 oz.	14 oz.
20	11 oz.	22 oz.
24	16 oz.	31 oz.
30	25 oz.	49 oz.
36	35 oz.	70 oz.

Allow about six hours of contact time before using the water.

Another bacteriological sample should be taken after one week of use.

Water Sources (spring, lake, well, etc.) should be inspected for possible contamination routes (surface soil, runoff following rain and seepage from domestic waste disposal sites). Attempts at disinfecting the water alone without removing the source of contamination will not supply bacteriologically safe water on a continuing basis.

There are several types of low cost filters (ceramic, paper, carbon, diatomaceous earth sometimes impregnated with silver, etc.) that can be easily installed on taps or in water lines. These may be useful to remove particles if water is periodically turbid and are usually very successful. Filters, however, do not disinfect water but may reduce bacterial numbers. For safety, chlorination of filtered water is recommended.

SEPTIC TANK INSTALLATIONS

In Ontario, provincial law requires that you obtain permission in writing to install a septic tank system. Permission can be obtained from the local Medical Officer of Health or in some instances from the Regional Engineer of the Ministry of the Environment. Any other pertinent information such as sizes, types and location of septic tanks and tile fields can also be obtained from the same authority.

(i) General Guidelines

A septic tank should not be closer than:

- 50 feet to any well, lake, stream or pond.
- 5 feet to any building.
- 10 feet to any property boundary

The tile field should not be closer than:

- 100 feet to the nearest dug well.
- 50 feet to a drilled well which has a casing to 25 feet below ground.
- 25 feet to a building
- 10 feet to a property boundary.
- 50 feet to any lake, stream or pond.

The ideal location for a tile field is in a well drained, sandy loam soil remote from any wells or other drinking water sources. For the tile field to work satisfactorily, there should be at least 3 feet of soil between the bottom of the weeping tile trenches and the top of the ground water table or bedrock.

DYE TESTING OF SEPTIC TANK SYSTEMS

There is considerable interest among cottage owners to dye test their sewage systems, however, several problems are associated with dye testing. Dye would not be visible to the eye from a system that has a fairly direct

connection to the lake. Thus, if a cottager dye-tested his system and no dye was visible in the lake, he would assume that his system is satisfactory, which might not be the case. A low concentration of dye is not visible and therefore expensive equipment such as a fluorometer is required. Only qualified people with adequate equipment are capable of assessing a sewage system by using dye. In any case, it is likely that some of the water from a septic tank will eventually reach the lake. The important question is whether all contaminants including nutrients have been removed before it reaches the lake. To answer this question special knowledge of the system, soil depth and composition, underground geology of the region and the shape and flow of the shifting water table are required. Therefore, we recommend that this type of study should be performed only by qualified professionals.

BOATING REGULATION

In order to help protect the lakes and rivers of Ontario from pollution it is required by law that sewage (including garbage) from all pleasure craft, including houseboats must be retained in equipment of a type approved by the Ministry of the Environment. Equipment which will be approved by the Ministry of the Environment includes (1) retention devices with or without circulation which retain all toilet wastes for disposal ashore, and (2) incinerating devices which reduce all sewage to ash.

To be approved, equipment shall:

1. be non-portable,
2. be constructed of structurally sound material,
3. have adequate capacity for expected use
4. be properly installed,

5. in the case of storage devices, be equipped with the necessary pipes and fittings conveniently located for pump-out by shore-based facilities (although not specified, a pump-out deck fitting with 1.1/2 inch National Pipe Thread is commonly used).

An Ontario regulation requires that marinas and yacht clubs provide or arrange pump-out service for the customers and members who have toilet-equipped boats. In addition, all marinas and yacht clubs must provide litter containers that can be conveniently used by occupants of pleasure boats.

The following "Tips" may be of assistance to you in regards to boating:

1. Motors should be in good mechanical condition and properly tuned.
2. When a tank for outboard motor testing is used, the contents should not be emptied into the water.
3. Fuel hoses must be in good condition and all connections tight.
4. If the bilge is cleaned prior to the boating season, the waste material must not be dumped into the water.
5. Fuel tanks must not be overfilled and space must be left for expansion if the fuel warms up.
6. Vent pipes should not be obstructed and fuel needs to be dispensed at a correct rate to prevent "blow-back".
7. Empty oil cans must be deposited in a leak-proof receptacle.

ICE-ORIENTED RECREATIONAL ACTIVITIES

The Ministry of the Environment is presently preparing regulations to control pollution from ice-oriented recreational activities. In past years, there has been indiscriminate dumping of garbage and sewage on the ice. The bottoms of fish huts have been left on the ice and become a navigational hazard to boaters in the spring. Broken glass has been left on the ice only to become

injurious to swimmers. With the anticipated introduction of the regulations, many of these abuses will become illegal.

EUTROPHICATION OR EXCESSIVE FERTILIZATION AND LAKE PROCESSES

The changes in water quality brought about by excessive inputs of nutrients to lakes are usually evidenced by excessive growths of algae and aquatic plants.

Aquatic plants and algae are important in maintaining a balanced aquatic environment. They provide food and a suitable environment for the growth of aquatic invertebrate organisms which serve as food for fish. Shade from large aquatic plants helps to keep the lower water cool which is essential to certain species of fish and also provide protection for young game and forage fish. Numerous aquatic plants are utilized for food and/or protection by many species of waterfowl. However, too much growth creates an imbalance in the natural plant and animal community particularly with respect to oxygen conditions, and some desirable forms of life such as sport fish are eliminated and unsightly algae scums can form. The lake will not be "dead" but rather abound with life which unfortunately is not considered aesthetically pleasing. This change to poor water quality becomes apparent after a period of years in which extra nutrients are added to the lake and a return to the natural state may also take a number of years after the nutrient inputs are stopped. Changes in water quality with depth are a very important characteristic of a lake. Water temperatures are uniform throughout the lake in the early spring and winds generally keep the entire volume well mixed. Shallow lakes may remain well mixed all summer so that water quality will be the same throughout. On the other hand, in deep lakes, the surface waters

warm up during late spring and early summer and float on the cooler more dense water below. The difference in density offers a resistance to mixing by wind action and many lakes do not become fully mixed again until the surface waters cool down in the fall. The bottom water receives no oxygen from the atmosphere during this unmixed period and the dissolved oxygen supply may be all used up by bacteria as they decompose organic matter. Cold water fish, such as trout, will have to move to the warm surface waters to get oxygen and because of the high water temperatures they will not thrive, so that the species will probably die out (see Figure next page).

Low oxygen conditions in the bottom waters are not necessarily an indication of pollution but excessive aquatic plant and algae growth and subsequent decomposition can aggravate the condition and in some cases can result in zero oxygen levels in lakes which had previously held some oxygen in the bottom waters all summer. Although plant nutrients normally accumulate in the bottom waters of lakes, they do so to a much greater extent if there is no oxygen present. These nutrients become available for algae in the surface waters when the lake mixes in the fall and dense algae growths can result. Consequently, lakes which have no oxygen in the bottom water during the summer are more prone to having algae problems and are more vulnerable to nutrient inputs than lakes which retain some oxygen.

CONTROL OF AQUATIC PLANTS AND ALGAE

Usually aquatic weed growths are heaviest in shallow shoreline areas where adequate light and nutrient conditions prevail.

Extensive aquatic plant and algal growths sometimes interfere with

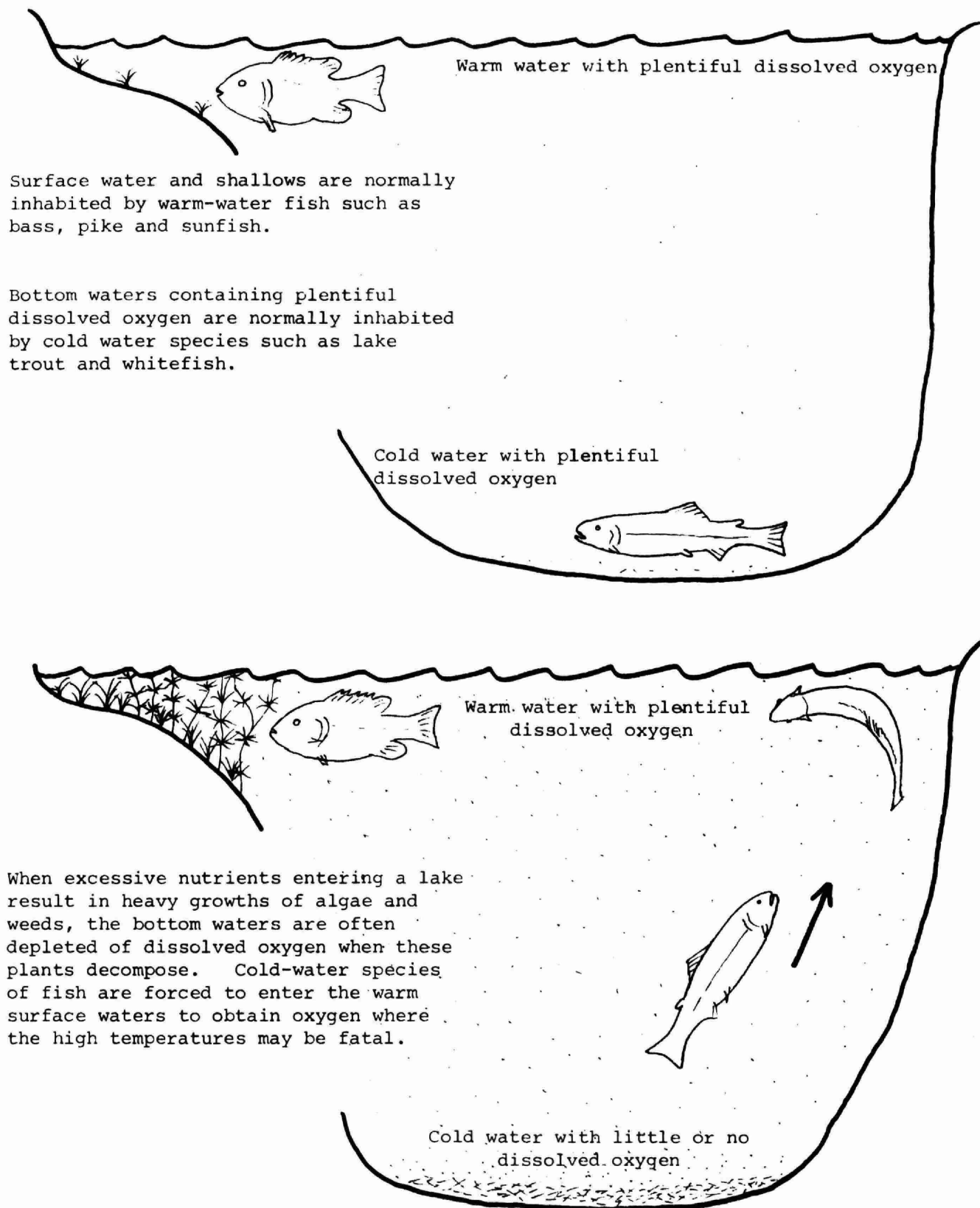


FIGURE A-1: DECOMPOSITION OF PLANT MATTER AT THE LAKE BOTTOM CAN LEAD TO DEATH OF DEEP-WATER FISH SPECIES.

boating and swimming and ultimately diminish shoreline property values.

Control of aquatic plants may be achieved by either chemical or mechanical means. Chemical methods of control are currently the most practical, considering the ease with which they are applied. However, the herbicides and algicides currently available generally provide control for only a single season. It is important to ensure that an algicide or herbicide which kills the plants causing the nuisance, does not affect fish or other aquatic life and should be reasonable in cost. At the present time, there is no one chemical which will adequately control all species of algae and other aquatic plants. Chemical control in the province is regulated by the Ministry of the Environment and a permit must be granted prior to any operation. Simple raking and chain dragging operations to control submergent species have been successfully employed in a number of situations; however, the plants soon re-establish themselves. Removal of weeds by underwater mowing techniques is certainly the most attractive method of control and is currently being evaluated in Chemung Lake near Peterborough. Guidelines and summaries of control methods, and applications for permits are available from the Biology Section, Water Quality Branch, Ministry of the Environment, Box 213, Rexdale, Ontario.

PHOSPHORUS AND DETERGENTS

Scientists have recognized that phosphorus is the key nutrient in stimulating algal and plant growth in lakes and streams.

In the past years, approximately 50% of the phosphorus contributed by municipal sewage was added by detergents. Federal regulations reduced

the phosphate content as P_2O_5 in laundry detergents from approximately 50% to 20% on August 1, 1970 and to 5% on January 1, 1973.

It should be recognized that automatic dishwashing compounds were not subject to the recently approved government regulations and that surprisingly high numbers of automatic dishwashers are present in resort areas (a questionnaire indicated that about 30% of the cottages in the Muskoka Lakes have automatic dishwashers). Cottagers utilizing such conveniences may be contributing significant amounts of phosphorus to recreational lakes. Indeed, in most of Ontario's vacation land, the source of domestic water is soft enough to allow the exclusive use of liquid dishwashing compounds, soap and soap-flakes.

ONTARIO'S PHOSPHORUS REMOVAL PROGRAM

By 1975, the Government of Ontario expects to have controls in operation at more than 200 municipal wastewater treatment plants across the province serving some 4.7 million persons. This represents about 90% of the population serviced with sewers. The program is in response to the International Joint Commission recommendations as embodied in the Great Lakes Water Quality Agreement and studies carried out by the Ministry of the Environment on inland recreational waters which showed phosphorus to be a major factor influencing eutrophication. The program makes provision for nutrient control in the Upper and Lower Great Lakes, the Ottawa River system and in prime recreational waters where the need is demonstrated or where emphasis is placed upon prevention of localized eutrophication.

Phosphorus removal facilities must be operational at wastewater treatment plants by December 31, 1973, in the most critically affected areas

of the province, including all of the plants in the Lake Erie drainage basin and the inland recreational areas. The operational date for plants discharging to waters deemed to be in less critical condition which includes plants larger than one million gallons per day (1 mgd) discharging to Lake Ontario and to the Ottawa River system, is December 31, 1975. The 1973 phase of the program will involve 156 plants of which 85 are in the Lake Erie basin and another 30 in the Lake Huron drainage basin. The capacities of these plants range from 0.04 to 24.0 mgd, serving an estimated population of 1,600,000 persons. The 1975 phase will bring into operation another 57 plants ranging in size from 0.3 to 180 mgd serving an additional 3,100,000 persons. Treatment facilities utilizing the Lower Great Lakes must meet effluent guidelines of less than 1.0 milligrams per litre of total phosphorus in their final effluent. Facilities utilizing the Upper Great Lakes, the Ottawa River Basin and certain areas of Georgian Bay where needs have been demonstrated must remove at least 80% of the phosphorus reaching their sewage treatment plants.

CONTROL OF BITING INSECTS

Mosquitoes and blackflies often interfere with the enjoyment of recreational facilities at the lake-side vacation property. Pesticidal spraying or fogging in the vicinity of cottages produces extremely temporary benefits and usually do not justify the hazard involved in contaminating the nearby water. Eradication of biting fly populations is not possible under any circumstances and significant control is rarely achieved in the absence of large-scale abatement programmes involving substantial funds and trained personnel. Limited use of approved

larvicides in small areas of swamp or in rain pools close to residences on private property may be undertaken by individual landowners, but permits are necessary wherever treated waters may contaminate adjacent streams or lakes. The use of repellents and light traps is encouraged as are attempts to reduce mosquito larval habitat by improving land drainage. Applications for permits to apply insecticides as well as technical advice can be obtained from the Biology Section, Water Quality Branch of the Ministry of the Environment, Box 213, Rexdale, Ontario.